PROTECTING AND CLEANING HANDS CONTAMINATED BY SYNTHETIC FALLOUT UNDER FIELD CONDITIONS

Research and Development Technical Report USNRDL-TR-256
NY 320-001
U.S. Army

27 August 1958

by

R.H. Black

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U N C L A S S I F I E D

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Health and Safety

Technical Objective
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U N C L A S S I F I E D

ABSTRACT

Hands of field test personnel became radioactively contaminated with (a) dust or slurry synthetic fallouts containing La^{140} tracer, and (b) La^{140} in acid solution. Two protective creams and several cleaning materials were used in an attempt to reduce adherance of contaminant and to facilitate decontamination. The protective creams were not found to be advantageous. Three experimental cleaning solutions (isotonic neutral solution of a complexing agent plus a detergent and germicide; an isotonic saline solution at pH 2.0 plus detergent and germicide; and a 3% citric acid solution) were found to decontaminate skin more readily than soap and water. A waterless mechanic's hand cleaner was found to clean hands with the same effectiveness as soap and water.

NONTECHNICAL SUMMARY

The Problem

Radioactive contamination of the skin of personnel following a nuclear weapon detonation or a radiological accident can constitute a serious health problem. However, study of preventing contamination or removing contaminant until now has been limited to laboratory-scale tests of creams and liquids for protecting and cleaning hands. Evaluation under field conditions has been lacking.

Findings

The hands of personnel became contaminated with synthetic fallout during a land reclamation field test. Two protective creams were used in an attempt to reduce adherance of the contaminant, and several cleaning materials to facilitate decontamination.

The protective creams were not found to be advantageous. Three experimental cleaning solutions were found to decontaminate skin more readily than soap and water. A waterless hand cleaner was found to clean hands with the same effectiveness as soap and water.

ADMINISTRATIVE INFORMATION

The work reported was an outgrowth of an investigation conducted by this laboratory under the sponsorship of the Bureau of Yards and Docks and the U. S. Army (OCE). This investigation is described, as Program 6, Problem 3, in this laboratory's Preliminary Presentation of USNRDL Technical Program for FY 1957, dated February 1956.

ACKNOWLEDGMENTS

This test was made possible by the cooperation of Mr. J. D. Sartor, who was conducting a field test in which the synthetic fallout was produced and utilized. He and his entire team were most generous in donating time for the hand-cleaning tests.

The technical assistance of Mr. D. A. Gustafson, of the San Francisco Naval Shipyard Electronics Shop, was invaluable for maintaining continuous instrument operation.

REPORT OF INVESTIGATION

INTRODUCTION

Radioactive contamination of the skin of personnel following a nuclear weapon detonation or a radiological accident can constitute a serious health problem. However, study of preventing contamination or removing contaminant until now has been limited to laboratory tests on the cleaning of contaminated skin. No information is available on the relative merits of cleaning materials used under field conditions. Prevention through the use of rubber gloves is desirable, but under field conditions this may not always be practical or possible. Also, contaminants have been known to penetrate surgeon's gloves.[1] Therefore, it is necessary to have alternate means of protecting or cleaning hands which are vulnerable to contamination under field conditions.

Various laboratories that utilize radioisotopes in research have published the results of case studies in which the skin of personnel which had become accidentally contaminated were decontaminated. Most of these decontaminations were performed with strong chemical reagents which are generally not applicable to field work inasmuch as they require careful supervision to prevent serious skin irritation.

Mild chemical skin decontamination methods were studied at USNRDL in 1949.[2] Two types of solutions that appeared suitable were developed: one type consisted of isotonic neutral solutions of complexing agents, plus a detergent and germicide; the other was an isotonic saline solution at pH 2.0, plus a detergent and germicide. The toxicity of these solutions was studied in 1950;[3] both were found slightly irritating, probably due to the germicide. This study also showed that these solutions tended to increase the absorption into the body of a soluble $Sr^{89}Cl_2$ contaminant.

At Operation CASTLE the hands of technical personnel and decontamination crews often became contaminated. Usually the contaminant was removable by scrubbing with soap and water or scrubbing with a mixture of

cornmeal and detergent, but on one particular individual such treatment did not remove the contaminant. An ammoniacal petroleum-based waterless hand cleaner was found to be effective in cleaning this individual's hands.

Barrier creams, advertised as reducing dermatitis caused by contact agents, such as solvents, grimes, pollens, and irritating plants, are a possible preventive. The use of barrier creams has reduced the problem of skin contamination in one atomic energy plant;[1] but tests using barrier creams to reduce the effect of other contact agents have not been conclusive.[4]

Barrier creams may actually interpose a physical barrier between the skin and potential contaminating agents. The cream, if applied heavily enough, might even act as a shield against alpha and low-energy beta radiation. Personnel from this laboratory who have used various barrier creams found them generally useful for reducing the effect required to clean hands after working with ordinary industrial greases, paints, and grimes, and the creams caused no skin irritation. It was upon these bases that a test of the value of barrier creams was proposed for Operation REDWING as part of Project 2.8. Only limited data were obtained due to the effectiveness of the Radiological Safety Program.[5]

USNRDL conducted a land target recovery field test at Camp Stoneman, Pittsburg, California, in September 1956. Full-scale decontamination procedures were used on limited areas contaminated with synthetic fallout; this provided an excellent opportunity to test methods and procedures of hand decontamination. This report describes the experiment which was undertaken. The objectives were to determine the effectiveness of barrier creams in preventing contamination from adhering to hands and to determine the effectiveness of a waterless cleaner and three experimental solutions in removing radiological contamination from the skin of the hands.

EXPERIMENTAL PLAN

During the land target recovery tests the normal field operation duties included: La^{140} solution preparation; mixing the La^{140} solution with soil to make the synthetic fallout; dispersing the synthetic fallout; radiation survey; and decontamination operations. Selected test personnel were given the experimental protection of a barrier cream prior to entering the contaminated area. Any person returning from the contaminated area with over 500 c/min on his hands, as determined by the Radiological Safety Monitor, was directed by the monitor to the hand cleaning center where a sequence of count-clean-count was performed on the palms of his hands using the experimental procedures described below in the section headed "Cleaning." When the experimental hand cleaning sequence for an individual was completed, he was released to the Radiological Safety Group for routine personnel decontamination.

Contaminant

Three types of contaminant were used in this experiment. Most of the data on which this report is based came from contamination by synthetic fallout traced with La^{140}; other data came from contamination by acid La^{140} solution used in preparing the synthetic fallouts. The La^{140} is a β- and γ-emitting radioisotope with a 40-hr half-life.

The two types of synthetic fallout were: dry, using ambrose clay loam, and slurry, using San Francisco Bay harbor bottom material. The La^{140} tracer concentrations for these synthetic fallouts were 7.5 μc/g and 0.75 μc/g, giving a total of four combinations.[6] Previous experiments had indicated that the La^{140} was firmly adsorbed to the synthetic fallout and that cleaning operations did not desorb the La^{140} from the bulk carrier material; in other words, the detection of La^{140} radiations was a good indication of the presence of synthetic fallout.[7]

The third contaminant type was the acid La^{140} solution. The La^{140} in this solution was in a chemical form suitable for absorbing onto most solids. The La^{140} in this form was not a tracer for a bulk carrier material; it was the contaminant.

Protection

The routine rad-safe procedure for protecting the hands of those performing the La^{140} solution preparation included the wearing of surgeon's gloves, while cotton gloves were worn when manual work was being performed. Additional experimental protection was provided to randomly selected personnel by the application of a barrier cream prior to working in the contaminated areas.

The creams tested were Cream A, a hard, wax-like cream,[8] and Cream B, a soft, easily smoothed cream similar to common cleansing cream.* Both were proprietary preparations selected as suitable for wet work.

Cleaning

The hand cleaning was performed by test personnel under supervision. A vigorous 1- to 2-min wash was prescribed, but not timed. Drying was done with paper towels. The formulations of the different washes tested and application procedures are given in Table 1.

Soap and water washing was chosen as a control. The EDTA and saline solutions were selected as a result of previous work at USNRDL.[2] The waterless cleaner was selected because of favorable experience at Operation CASTLE. The citric acid was recommended by the Radiological Safety Representative for the field tests.

* "Kerodex 71," manufactured by Ayrst Laboratories, New York, New York.

TABLE 1

Cleaning Formulations and Procedures

Wash	Formulation	% Wt	Approximate Amount per Application	Cleaning Sequence[d]
Soap and water	Stearate Soap, G51-S-1870		Not Limited	Wet hands, lather, rinse, wipe dry
Waterless Hand Cleaner	Ammoniacal Petroleum-based proprietary formulation		15 cc	Rub into skin, wipe clean with 2 towels
EDTA	4Na-EDTA[a] Disinfectant[b] Wetting Agent[c] Water HCl (to adjust pH to 7)	3.0 0.1 0.4 96.5	50 ml	Rub during application, rinse, wipe dry
Saline	NaCl (isotonic) Disinfectant[b] Wetting agent[c] Water HCl (to adjust pH to 2)	0.9 0.1 0.4 98.6	50 ml	Rub during application, rinse, wipe dry
Citric Acid	Citric acid Water	3 97	50 ml	Rub during application, rinse, wipe dry

(a) Tetra sodium ethylenediamintetraacetic acid.
(b) Di-isobutylphenoxyethoxyethyldimetbylbenzylammonium-chloridemonohydrate.
(c) Aklylarylpolyetheralcohol.
(d) All rinses were with tap water, all drying was with one paper towel unless otherwise noted.

Two washings by the same method were performed in each case, unless one wash brought the count very close to the background count. More than two washings using the same method were performed when activity levels permitted.

In some instances of unusually high beta readings, more than one cleaning method was prescribed.

Instrumentation

The instrument for routine initial radiological safety monitoring was a Geiger-Muller end-window count rate meter.* The instrument used in this study for assessing contamination on the palms of the hands was the USNRDL Large Area Beta Detector. This instrument, designed and built by the Nucleonics Division of USNRDL, consists of a modified AN/UDR-9 radiac set, a pre-amplifier, and a detector. A 5-min timer** replaces the normal switching and timing circuits of the AN/UDR-9 to simplify the operation of the instrument. The pre-amplifier is a 3-tube device with a voltage gain of approximately 1,000. The detector uses an 8 x 10 x 1/8-in. sheet of plastic scintillant.*** The scintillant is coupled with 10^6 centistoke DC-200 silicone oil to a segmented plexiglas light-pipe, which is coupled to a 5-in. diameter photomultiplier tube. **** The detector pre-amplifier combination is contained in a light-tight box with a removable cover. The instrument was set to give a 15-sec count. The physical relationship between a person with his hands in position for counting and the elements of the beta counter preamplifier is shown in Fig. 1.

Two 12-μc samples of synthetic fallout were prepared for instrument standardization. Sample 1 was 0.75 μc/g San Francisco Bay mud (dried). Sample 2 was 7.5 μc/g San Francisco Bay mud (dried). The averaged 15-sec count was used as the standardization factor to convert from counts per 15 sec (c/15 sec) to microcuries (μc).

RESULTS AND DISCUSSION

The effectiveness of the various methods tested is expressed as a residual fraction, the beta radiation reading of the palms of the hands taken immediately after a washing divided by the beta reading taken

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* Model 2750, Berkeley Scientific Div., Beckman Instruments Corp., Richmond, Calif.

** "Microflex" Timer, Eagle Signal Corp., Moline, Ill.

*** "Scintilon B", National Radiac, Newark, N. J.

**** Type 6364, A.B. Dumont Inc., Clifton, New Jersey.

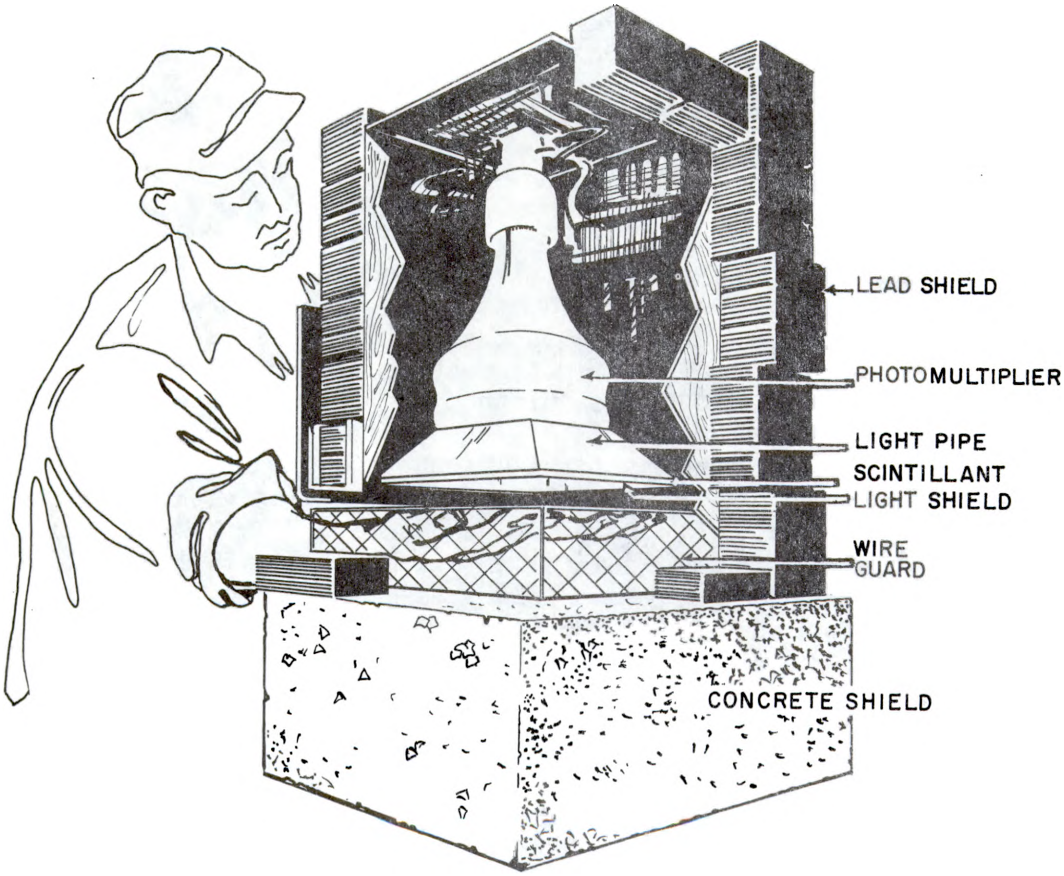

Fig. 1 Large-area Beta Detector in Use

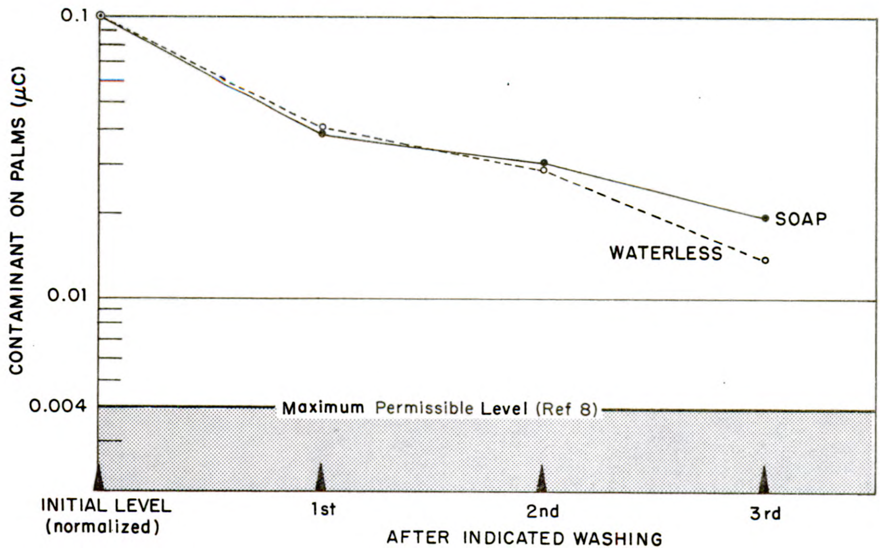

Fig. 2 Comparison of Waterless Cleaner With Soap and Water

immediately before the washing (that is, the readings taken before and after any one of several washings). All types of contaminant are included in the evaluation of a cleaning method, unless otherwise noted.

Protection Methods

The two barrier creams tested, when used in conjunction with a soap and water wash, gave approximately the same results as a soap and water wash with no special protection (Table 2).

Cleaning Methods

The residual fractions for the soap, EDTA, and waterless cleaning methods were divided into three groups to determine gross effects due to initial contamination level. These group divisions were based on initial level: less than 0.03 μc, 0.03 to 0.3 μc, and greater than 0.3 μc. The logarithmic mean residual fractions are presented in Table 2. They were normalized to 1 μc, 0.1 μc and 0.01 μc for convenience of comparison (Figs. 2 and 3). The results presented are for all three contaminant types combined. The British maximum permissible level[9] of fixed radioactivity on the skin is 10^{-5} μc/cm^2, which is equal to 0.004 μc uniformly distributed on the palms of both hands.*

* The U. S. has no comparable maximum permissible level.

TABLE 2

Residual Fractions From the Various Cleaning and Protective Agents[(a)]

Agent	Initial Level Range (μc)	Residual Fraction and Standard Deviation for Each Wash								
		First Wash			Second Wash			Third Wash		
		2nd count / 1st count	Std. Dev. (%)	No. of Subjects	2nd count / 3rd count	Std. Dev. (%)	No. of Subjects	4th count / 3rd count	Std. Dev. (%)	No. of Subjects
					Protective					
Cream A, Soap wash	5.2 to 0.53	0.17		3	0.32		3	0.71		2
Cream B, Soap wash	2.4 to 0.01	0.40	55	10	0.74	32	9	0.91		3
					Cleaning					
Soap	> 0.3	0.15	282	12	0.64	52	9	0.69		4
	0.03 to 0.3	0.39	161	30	0.80	23	19	0.63	69	7
	< 0.03	0.35	92	16	0.79	23	7	0.19		1
Water-less	> 0.3	0.35	45	7	0.68	23	7	0.62		4
	0.03 to 0.3	0.41	41	10	0.72	18	10	0.47		2
	< 0.03	0.35	74	12	0.56		2			
EDTA	> 0.3	0.053	220	10	0.51	120	7	0.56		4
	0.03 to 0.3	0.06	240	24	0.59		4			
	< 0.03	0.15	350	7						
Saline, pH2	2.4 to 0.01	0.12	146	23	0.55	29	10			
Citric Acid	1.0 to 0.01	0.074	298	13	0.49	38	6			
Soap	4.0 to 0.15	0.37	59	6						
EDTA					0.28	26	6			
Soap	0.5 to 0.08	0.45	23	5	0.89	7	5			
Saline								0.28	70	5

(a) Computed as logrithmic means. Standard deviation was calculated from the log standard deviation and is expressed as (antilog (log std. dev.) 1.00) x 100%.

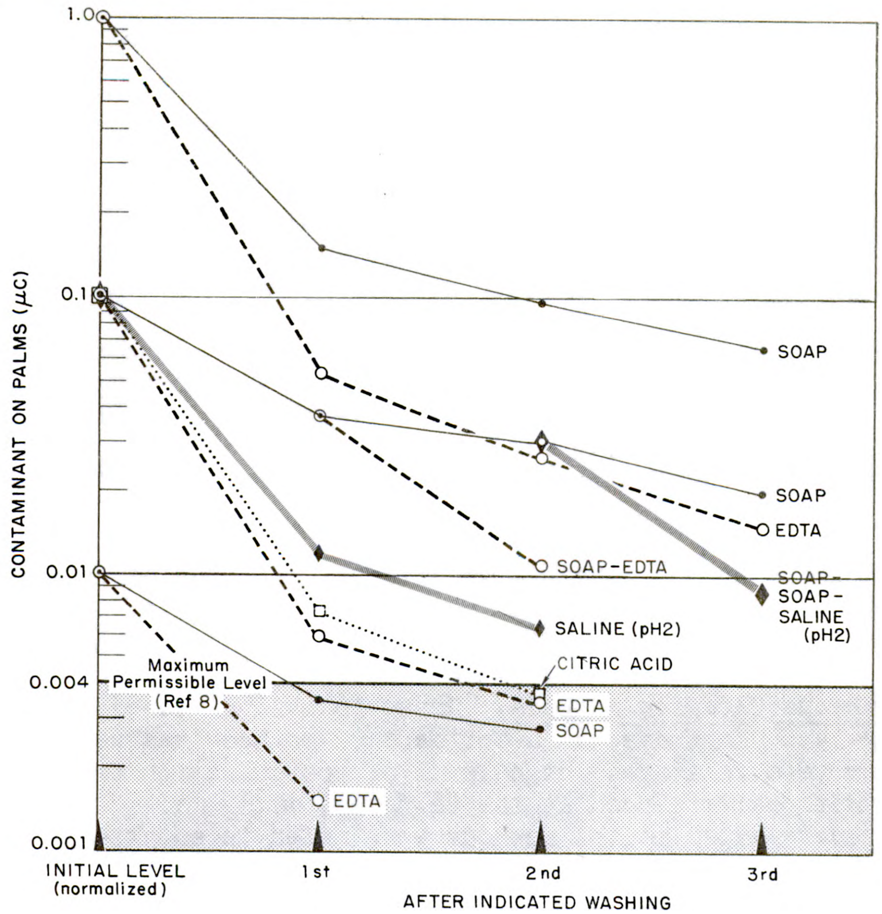

Fig. 3 Comparison of Aqueous Cleaning Methods

Waterless Hand Cleaner. The averages of the first washings with waterless cleaner were approximately as effective as the equivalent soap washings (Table 2, Fig. 2). A review of the washing procedure will show that while the soap and water washing method was not limited by the amount of water that could be used, the waterless method used only 15 cc of cleaner for one washing.

EDTA. The average residual contamination from washing with EDTA was considerably lower than that of soap and water (Table 2, Fig. 3).

To further test the effectiveness of EDTA, we deviated from the original plan of using a single washing method; the initial washing was with soap, the second with EDTA. The result of this test showed that the

residual fraction for the EDTA wash was smaller than residual fraction for the soap wash. Also, two EDTA washings removed more contamination than the one soap wash plus one EDTA wash.

Saline Solution, pH-2. The average residual contamination from washing with the acidic saline solution was considerably lower than that of soap and somewhat higher than that of the EDTA (Table 2, Fig. 3).

A test, similar to the special test for EDTA, was performed using the saline solution (Table 2, Fig. 3). The first two washings were with soap. The third was with saline solution. The residual fraction from the saline solution washing averaged about half the residual fraction for the equivalent soap wash, showing that the saline solution removed the contaminant to a greater degree than soap.

Citric Acid Solution. The citric acid solution was given a cursory test (Table 2, Fig. 3). The average residual from the citric acid washing was approximately the same as that of the EDTA and saline solutions.

Miscellaneous Cleaning Methods. Three individual case studies are reported (Fig. 4). In these, an assortment of methods was used on each subject to remove a relatively high level of contamination from the hands. Conventional methods were used at the beginning and as they appeared to lose effectiveness experimental methods were tried in an attempt to reduce contamination of the hands as much as possible. In two of these cases it appeared as though contamination were "fixed" at approximately 0.1 μc but upon changing to EDTA wash the hands were cleaned to less than 0.01 μc.

Near the conclusion of the test series, two individuals' hands became contaminated to approximately 5 μc, presumably from the acid La^{140} solution. One sequence of soap scrub, water rinse, EDTA scrub, water rinse (using a nylon scrub brush and warm solutions, including rinse) was used as a washing procedure. The final levels were approximately 0.05 μc, or overall residual fraction of 0.01. The cleaning sequence used in these two cases may be of interest if further investigative work is to be performed.

In another instance a man mistakenly used the waste water from the day's hand decontamination work (containing a combination of all cleaning solutions) as the wash for his hands. His hands had an initial contamination level of .006 μc, which was considerable lower than the average for the day; but the waste solution cleaned his hands to .002 μc, nearly background. This one case indicates that in the event of water shortage, cleaning solutions can, perhaps, be reused. Naturally, more data would be required to substantiate the idea and to explore possible adverse side effects.

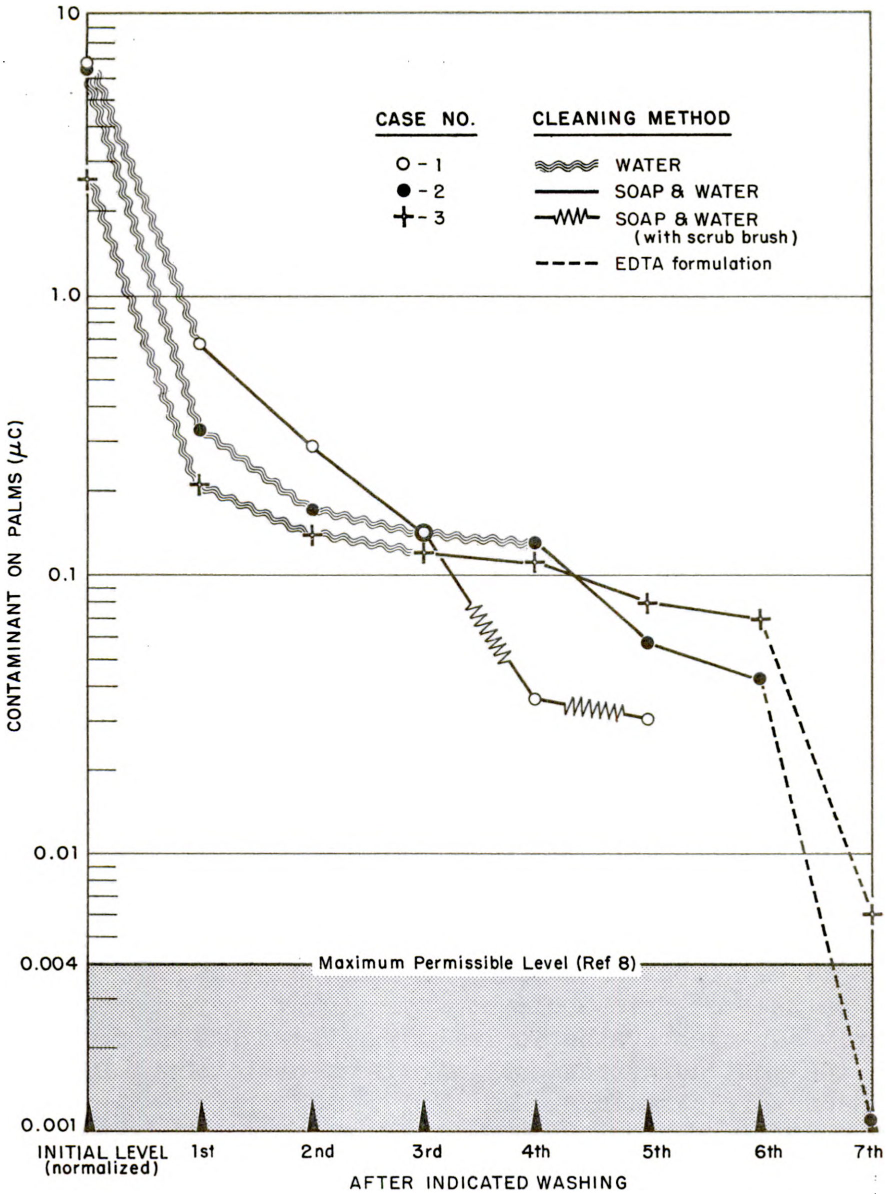

Fig. 4 Three Case Studies

A nylon brush was used to a very limited degree against resistant contaminant, as the Health Physics Representative had warned us that the contaminant would be driven into the skin by brushing. No adverse effects were observed. The results of one case where a nylon brush was used are presented (Fig. 4). Further investigation could be applied to re-evaluating the effect of scrubbing the skin with a nylon brush, perhaps after an initial wash without brushing.

Miscellaneous Observations

Physiological Effects. No attempt was made to determine toxic effects of the cleaning preparation or barrier creams. Each person used several materials over the period of the field operation; therefore effects could not be isolated. Several persons, who did not regularly use the soft cream emollient which was available, complained of chapped skin. Previous work[3] indicated a slight toxicity of two cleaning solutions traceable primarily to the disinfectant.

Comparison of Contaminant Types. In a parallel analysis the data for soap washing were separated by contaminant type and compared, i.e., acid La^{140} solution, slurry 0.75 μc/g, slurry 7.5 μc/g, loam 0.75 μc/g, loam 7.5 μc/g. Slurry contaminant with 7.5 μc/g was the only one that showed a noticeably different residual fraction; it apparently was easier to remove than other contaminants. As there were only four data points showing this effect no definite conclusions can be drawn concerning the effect of contaminant type.

Initial Level Effect. The effectiveness of the first washing was related to the initial contamination level. In general, a lower residual fraction was obtained from the washing of hands contaminated to a higher initial level of La^{140}. This would be expected if there were a maximum level of tightly adhering synthetic fallout. There was no observable difference in the residual fractions, with respect to contamination level, for the second or third washings.

Comparison With Previous Laboratory Study. Comparison of some of the findings from this field test and a laboratory experiment performed in 1949,[2] upon which a portion of the field test work was based, show that in both cases EDTA and saline solutions were more effective decontamination agents than soap, leaving a residual fraction of approximately half that of soap. Laboratory experiments using rats gave much lower residual fractions than those observed at the field test; however, the second washings at the field test gave residual fractions numerically almost the same as the second washing on the skin from a cadaver in laboratory tests. An additional factor, which lends further interest to the correspondence of

the findings, is that the contaminating agents were quite different: synthetic fallout (and La^{+++} in acid solution, in a few instances) was used for field work, while a neutral solution of Sr^{++} was used in the laboratory experiments.

Laboratory-scale decontamination tests were performed with the cooperation of human volunteer subjects[10] at approximately the same time as the field tests. A synthetic fallout, composed of Ambrose clay-loam traced with La^{140}, was dry-sprayed onto a 10-cm^2 area of the underside of the forearm, then rubbed into the skin with a rounded glass rod.

The residual fractions resulting from the cleaning operations were much lower for the laboratory tests than for the field tests, indicating that the methods were more effective in removing the synthetic fallout under the laboratory conditions. This may have been a result of a combination of effects, among which are the type of skin studied (i.e., palms vs underside of forearm), the total area contaminated, the mechanical action grinding the synthetic fallout into skin and mechanical action of scrubbing, the degree of supervision, the synthetic fallout contact time, etc.

However, the qualitative findings of both tests were essentially the same: barrier creams offered no large decontamination advantage, the first wash was the most effective wash (when a single cleaning agent was used), waterless mechanic's hand cleaner was at least as effective a decontamination agent as soap and water, and EDTA and citric acid were more effective than soap as decontamination agents.

Potential Decontamination Methods. Some cleaning formulations have been suspected of increasing the absorption of $Sr^{89}Cl_2$ solution into the body.[3] However, before any cleaner is disqualified for this reason, all its properties should be weighed in the light of anticipated field conditions. It may be that after the contaminant has been in contact with skin for several hours, the additional absorption caused by the use of a special cleaner would be negligible. Furthermore, it may be possible that for some instances of high level contamination, a two-part wash (such as described in the second paragraph under "Miscellaneous Cleaning Methods," would be desirable in an effort to maximize removal and minimize absorption.

The wetting agent, used alone in 0.5-percent solution has been shown to be a good decontamination agent.[2] It may be advantageous to further evaluate this agent for absorption, toxicity, and decontamination effectiveness under field conditions.

CONCLUSIONS

The barrier cream pre-treatments did not detectably alter the effort required to remove the contaminants by soap and water washing.

The waterless hand cleaner showed the same effectiveness as soap and water in removing contaminant from the hands, but required the least total material volume of all cleaners tested.

The EDTA, saline, and citric acid solutions (as formulated) were more effective than soap and water in removing the contaminant.

There was no observable difference in decontamination effectiveness traceable to contaminant type.

There is no method yet which has shown itself to be reliable enough in cleaning contaminated hands to be used without the necessity of a radiation check after washing, to comply with peace-time maximum permissable levels.

Approved by:

E. R. Tompkins

E. R. TOMPKINS
Head, Chemical Technology Division

For the Scientific Director

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109	Commander, Special Weapons Center, Kirtland AFB
110	Director, Air University Library, Maxwell AFB
111-112	Commander, Technical Training Wing, 3415th TTG
113	CG, Cambridge Research Center (CRZT)

OTHER DOD ACTIVITIES

114	Chief, Armed Forces Special Weapons Project
115	Commander, FC/AFSWP, Sandia Base (FCTG Library)
116	Commander, FC/AFSWP, Sandia Base (FCDV)

117	OIC, Livermore Branch, FC/AFSWP
118	Assistant Secretary of Defense (Res. and Dev.)
119	National Library of Medicine
120-129	Armed Services Technical Information Agency

AEC ACTIVITIES AND OTHERS

130-131	Federal Civil Defense Administration
132	Also Products, Inc.
133-135	Argonne Cancer Research Hospital
136-145	Argonne National Laboratory
146-147	Atomic Bomb Casualty Commission
148-150	Atomic Energy Commission, Washington
151-152	Atomics International
153-154	Babcock and Wilcox Company
155-156	Battelle Memorial Institute
157-158	Bettis Plant
159	Boeing Airplane Company
160-163	Brookhaven National Laboratory
164	Brush Beryllium Company
165	Chicago Operations Office
166	Chicago Patent Group
167	Columbia University (Failla)
168	Columbia University (Hassialis)
169	Combustion Engineering, Inc.
170	Committee on Atomic Casualties, Washington
171	Committee on Effects of Atomic Radiation
172-173	Consolidated Vultee Aircraft Corporation
174	Convair-General Dynamics Corporation
175-177	Defense Research Member
178	Department of Food Technology, MIT
179	Dow Chemical Company, Pittsburg
180	Dow Chemical Company, Rocky Flats
181-183	duPont Company, Aiken
184	duPont Company, Wilmington
185-186	General Electric Company (ANPP)
187-192	General Electric Company, Richland
193-194	Goodyear Atomic Corporation
195	Hawaii Marine Laboratory
196-197	Iowa State College
198-200	Knolls Atomic Power Laboratory
201-202	Lockheed Aircraft Corporation, Marietta
203-204	Los Alamos Scientific Laboratory
205	Mallinckrodt Chemical Works
206	Massachusetts Institute of Technology (Hardy)
207	Mound Laboratory
208	National Advisory Committee for Aeronautics
209-210	National Bureau of Standards (Taylor)
211	National Lead Company, Inc., Winchester
212	National Lead Company of Ohio
213	New Brunswick Laboratory

214-215	New York Operations Office
216	Nuclear Development Corporation of America
217	Oak Ridge Institute of Nuclear Studies
218-222	Oak Ridge National Laboratory
223	Patent Branch, Washington
224-229	Phillips Petroleum Company
230-231	Public Health Service, Washington
232	Radioisotopes Laboratory (Thoma)
233	RAND Corporation
234	Sandia Corporation
235	Sylvania Electric Products, Inc.
236	Technical Research Group
237	Tennessee Valley Authority
238	The Martin Company
239	Union Carbide Nuclear Company (C-31 Plant)
240-241	Union Carbide Nuclear Company (ORGDP)
242-244	United Aircraft Corporation
245	U.S. Geological Survey, Naval Gun Factory
246	UCLA Medical Research Laboratory
247	University of California Medical Center
248-250	University of California Radiation Laboratory, Berkeley
251-252	University of California Radiation Laboratory, Livermore
253	University of Chicago Radiation Laboratory
254	University of Rochester (Technical Report Unit)
255	University of Tennessee (Hall)
256	University of Utah (Stover)
257	University of Washington (Applied Fisheries Lab.)
258	Weil, Dr. George L.
259	Western Reserve University
260	Westinghouse Electric Corporation
261-285	Technical Information Service, Oak Ridge

USNRDL

286-325	USNRDL, Technical Information Division

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